

PORCELAIN-ENAMELED TANKS

FOR DOMESTIC USE

COMMERCIAL STANDARD CS115-44

On April 22, 1943, at the instance of the porcelain enameled tank industry, a general conference of representative manufacturers, distributors, and users of porcelain-enameled tanks for domestic use adopted a recommended commercial standard for this commodity. Those concerned have since accepted and approved the standard as shown herein for promulgation by the U. S. Department of Commerce through the National Bureau of Standards.

The standard is effective for new production from July 1, 1944.

PURPOSE

1. The purpose is to establish standard specifications and methods of test as a line of demarcation between satisfactory and unsatisfactory porcelain-enameled tanks for domestic water service, for the guidance of manufacturers, distributors, retailers, and users.

SCOPE

2. This standard covers porcelain-enameled tanks for domestic use in sizes 15 to 80 gal inclusive for 300 lbs per sq in. maximum hydrostatic test pressure.

GENERAL REQUIREMENTS

3. Base metal. The metal base for the porcelain-enameled parts of the tank, such as shells and heads, shall be iron or steel of a quality suitable for porcelain enameling with the process and equipment of the manufacturer so as to result consistently in tanks which will pass the tests outlined herein.

3a. Thickness of base material. The metal shall be of sufficient thickness, so that the completed enameled tank shall consistently pass the tests as outlined in paragraph 9.

4. Enameling. The inside surfaces of all component parts of the tank, including fittings other than those made from corrosion-resistant materials referred to in paragraph 14, shall receive at least two separately fired coats of porcelain enamel completely covering all iron and steel surfaces which would otherwise be exposed to the circulation of the contents of the tank, and shall be free from all defects which will expose bare iron or steel



or which will result in corrosion in service. These defects shall include copper heads, blisters, pinholes, crazing, and fish scales, all as defined in Porcelain Enamel Institute bulletin Tentative Definitions of Porcelain Enamel Terms. Enamels containing lead, antimony, or arsenic shall not be used except for minute quantities of these elements occurring as impurities in the raw materials.

5. Operating conditions. Porcelain-enameled tanks shall:

- (a) Withstand the normal physical operating conditions for which they are labeled, such as pressure.
- (b) Withstand the chemical action of their contents in the service for which the tanks are designed, such as the corrosive action of hot water in range boilers and automatic water heaters.

DETAIL REQUIREMENTS

6. Standard types, sizes, and test pressures. As a guide in order to reduce to an absolute minimum the number of sizes of porcelain-enameled tanks for the various applications for domestic use, the following sizes and maximum test pressures are considered standard:

Type of tank for	Standard	sizes	Rated hydrostatic test pressure
	U. S. Gallons		lb/in ²
Range boilers-----	30	40 52	250 and 300
Gas water heaters-----	20	30 45 75	300
Electric water heaters-----	30	50 80	300
Domestic water systems-----	15 20 30	50 80	---
Water softeners-----	---	---	---

7. Storage-capacity rating. The storage capacity of the tank shall be within 7-1/2 percent of the capacity rating stated on the label.

8. Working-pressure rating. The rating for maximum working pressure of a porcelain-enameled tank shall be not greater than 42-1/2 percent of the rated hydrostatic test pressure marked thereon.

8a. Each finished tank shall withstand 50 percent of the rated hydrostatic test pressure without any leakage or failure of the enamel coating. Defects in the porcelain-enamel coating described in paragraph 4, which appear as a result of this pressure test, shall be construed as failure of the tank.

9. Rated hydrostatic test pressure. Representative finished tanks shall be subjected to the full rated hydrostatic test pressure without developing any leakage of water or permanent deformation of the tank cylinder beyond 0.2 percent in circumference or 0.5 percent of tank diameter for either top or bottom head when tested as described in paragraph 22.

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10. Pulsation pressure. Representative tanks shall withstand a hydrostatic pressure which is varied uniformly from 115 percent of the rated working pressure to 60 to 75 percent of the rated working pressure, not faster than 20 nor slower than 15 times per minute for 100,000 cycles, without rupture, leakage or permanent deformation beyond that specified in paragraph 9, and without damage to the porcelain enamel.

11. Enamel coverage. The continuity of the enamel covering shall be such as to pass the test described in paragraph 20.

12. Enamel thickness. The total thickness of enamel on the inside surface of any individual tank shall be not less than 0.007 in. nor greater than 0.025 in. at any one point, nor greater than 0.020 in. average over the tank, other than at final head welds, when tested as specified in paragraph 21.

13. Solubility of enamel. Neither of two specimens cut from the tank wall shall have a residual specular gloss of less than 50 percent of the original after subjection to the test described in paragraph 23.

14. Fittings (permanently attached to the tank). All tank fittings exposed to the contents of the tank shall be made of bronze, brass (at least 85 percent copper), stainless steel, or other corrosion-resistant materials suitable for the purpose, or be covered by enameling as described in paragraph 4.

14a. The fittings shall be so designed and attached to the tank that repeated tightening and loosening of connecting parts as will occur in actual installation will not result in leakage or fracturing of the interior porcelain-enameled surfaces.

14b. The junction between the fitting and the base metal shall be protected against corrosion on the inside of the tank.

15. Production inspection and sampling. As a part of the process of production, the manufacturer shall conduct the following inspections and tests, as well as such others as he deems necessary for maintaining the quality of the product.

15a. Visual inspection of enamel. The enamel on the inside of each tank shall be inspected after the final firing for continuity and defects prior to welding in one or both heads.

15b. Proof test. Each tank shall be proof tested as described in paragraph 8a.

15c. Hydrostatic-pressure test. At least 1/10 of 1 percent of the tanks and not less than one from each run of the same size and type shall be tested as described in paragraph 22. Records of such tests shall be kept and made available on demand of the customer or the testing laboratory.

15d. Pulsation-pressure tests. Representative tanks shall pass the test described in paragraph 19.

METHODS OF TEST

16. Acceptance tests.

16a. Two tanks shall be taken at random as samples for test. One shall be used for the hydrostatic-pressure test and solubility of enamel, and the other sample tank for the remainder of the tests in the following order: capacity, proof test, pulsation, enamel coverage, and thickness of enamel.

16b. Prior to any tests a visual inspection through all openings of both tanks shall be made. Any defects in the porcelain enamel, described under paragraph 4, shall be construed as failure of the tank and the tests omitted.

17. Rated capacity (ref. par. 7). The actual storage capacity shall be determined by weight. The tank shall be weighed empty and reweighed after being filled completely with water. Care shall be taken that the tank is in such a position that no air will be trapped in it. The capacity shall then be computed in U. S. Standard gallons for comparison with the manufacturer's rated capacity.

18. Proof test (ref. par. 8a).

18a. The porcelain-enameled tank shall be connected to a water supply through a suitable pump system, a calibrated Bourdon pressure gage graduated in increments of not more than 5 lb/in.², check valve, and shut off valves. The tank and system shall be filled with water at room temperature ($\pm 10^{\circ}\text{F}$) and at atmospheric pressure, care being exercised to avoid any pocketing of air. All tapped openings in the tank shall be closed by use of threaded fittings. If the tank is equipped with a pressure-relief device, the device shall be removed and the opening plugged.

18b. Hydrostatic pressure in the system shall be gradually raised until 50 percent of the rated hydrostatic test pressure within 2 lb/in.² is reached. This pressure shall be maintained for 1/2 hour. At the end of this time the pressure in the system shall be reduced to atmospheric. If, at any time during the application of this hydrostatic pressure test there is any leakage of water, the tank fails.

18c. A visual inspection of the porcelain enamel through the openings shall be made with the aid of internal illumination and, if defects are discerned, the tank fails.

19. Pulsation-pressure test on finished tank (ref. par. 10).

19a. The porcelain-enameled tank shall be connected to a pressure-controlled water-supply line. A recording engine indicator shall be fastened to the inlet or to an opening in the tank adjacent to the inlet as close to the tank as possible, and in such a manner that graphs of the actual pulsations can be taken.

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19b. A quick-acting valve, which shall be operated either by a cam or similar suitable means so that it will open and close within a range of from 15 to 20 times per minute, shall be attached to an opening of the tank as far removed from the inlet as possible. Care shall be exercised to avoid any pocketing of air in the system.

19c. The pulsations as prescribed shall be obtained through any convenient combination of line pressure, length and size of piping. Graphs shall be taken at the start of the test and every four hours during the test. A continuous record by recording gage of the line pressure shall be taken for the period of the test.

19d. The hydrostatic pressure in the tank shall be varied from 115 percent of the rated working pressure to 60 to 75 percent of the working pressure, not faster than 20 nor slower than 15 times a minute, for 100,000 cycles. The upper pressure limit shall be maintained within a tolerance of plus or minus 5 lb/in.², and the lower pressure limit shall be maintained within the range stated.

19e. If defects in the porcelain enamel, as described in paragraph 4, are discovered by visual inspection through the tank openings after this pressure test, or if a rupture, leakage or permanent deformation in excess of the limits specified under paragraph 9 occurs, the tank fails.

20. Enamel coverage.

20a. Copper sulfate-salt solution. The tank shall be placed in a horizontal position and filled completely with solution made with 10 parts of copper sulfate, 10 parts sodium chloride, 80 parts tap water, all by weight. Care shall be taken to obtain solution of the salts before running solution into tank. Tank and solution shall remain at 85 ± 20°F for 7 days. Tank shall be drained slowly without flushing or agitation, cut open, and suspected areas ringed with a grease pencil.

20b. The tank shall be cut by mechanical means into several pieces to facilitate thorough inspection. If this inspection shows crazing or that a pin-hole or larger area of base metal is exposed, the tank fails. In case the copper is thought to be deposited only on an iron particle on the surface of the enamel, the electric tester shall be used to determine whether the defect extends to the base metal or is on the surface of a sound enamel coat.

20c. Electric tester. Doubtful copper deposits may be tested by use of the R.C.A. Junior Ohmyst #165 or its equivalent. The wet contact may be a cotton rope having a short length of copper tubing (3 to 4 in.) swedged firmly over the rope. The lead wire (not the ground lead) should be soldered to the tubing and the whole suitably insulated with rubber tape. A 1-percent solution of sodium chloride in water may be used to keep the contact saturated, since quantitative results are not desired. The resistance-scale knob should be set for full-scale reading of 1 megohm. A positive reading on this scale shall constitute failure.

21. Thickness of enamel. (ref. par. 12). Thickness measurements shall be taken at not less than 20 representative points of the shell and heads of a cut open tank which has passed the test for enamel coverage, paragraph 20, using a calibrated magnetic or other thickness gage (G.E. magnetic thickness gage or equivalent).

22. Hydrostatic test to rated test pressure (ref. par. 9).

22a. The setup for the test is the same as under paragraph 18. Before starting the test, such measurements of the tank as are necessary to reveal permanent deformation resulting from the hydrostatic-pressure test shall be taken. These observations shall include circumferential measurements along the tank at intervals of not more than 12 in. by a method permitting readings of the changes to be made directly to 0.010 in. Extensometers reading to 0.001 in. shall also be placed with the movable spindles against top and bottom heads at places most likely to deform.

22b. Hydrostatic pressure in the system shall be gradually raised by means of the pump until the full rated hydrostatic test pressure is reached, within 15 lb/in.². This pressure shall be maintained for 1/2 hour at which time the pressure in the system shall be reduced to atmospheric and the measurements originally taken repeated. Permanent set shown by any circumference measurements shall not exceed 0.2 percent of the corresponding measurement taken prior to the application of the test pressure. Permanent set of either top or bottom head as shown by the extensometers shall not exceed 0.5 percent of the tank diameter. If at any time during the application of this test there is any leakage of water, the tank fails.

23. Solubility of enamel (ref. par. 13).

23a. Specimens. The specimens for the solubility test shall consist of two 3-3/4- by 4-inch sections cut from the outer wall (not the center flue) of the tank approximately midway between the ends. The 4-in. dimension shall be parallel to the axis of the tank, and the 3-3/4-in. dimension shall be measured as the chord of the arc formed by the specimen.

23b. Cleaning of specimens. The specimens shall be cleaned with a clean rag, wetted with a 1-percent solution of Na_2PO_4 (trisodium phosphate), rinsed, and dried.

23c. Initial gloss measurements. After drying, the specular gloss of the concave side of the specimen shall be measured on the Hunter Multipurpose Reflectometer, or the equivalent, having a corrected gloss scale, with the specimen guide in such position as approximately to center the specimen over the gloss opening. The 4-in. dimension (parallel to the axis of the tank) shall be parallel with the long axis of the gloss opening, and leakage of light shall be prevented by covering the specimen with a heavy black cloth extending beyond the edges during measurement. The specimen guide shall be firmly fixed and the specimen clamp adjusted so as to hold the specimen in a fixed and reproducible position. Several measurements shall then be made, removing the

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specimen from the gloss opening between measurements. If the values thus obtained do not agree within ± 0.03 on the gloss scale, readjustment of the specimen guide shall be made and the process repeated until reproducible readings are obtained. The specimen shall then be rotated 180° and a second reading obtained, following the same procedure as outlined above.

23d. Boiling-distilled-water treatment. The apparatus for the boiling-distilled-water treatment shall be as indicated in figure 1. The two specimens shall be clamped to the ends of the Pyrex cylinder and exposed to a 7-day (168 hours) treatment of continuously changing, boiling distilled water. During this period the flow of water into the glass cylinder shall be approximately 4 gallons per 24 hours. The distilled water shall have a pH value of 5.5 to 7.0. In case the pH of the water prior to boiling is below 6.8, it shall be determined that the pH can be raised to 6.8 by boiling. The rubber gaskets, as shown in figure 1, shall be thoroughly scrubbed prior to use with enamel slip and soap or a commercial cleansing powder, rinsed thoroughly in water, and finally boiled in distilled water for 20 minutes.

23e. Heat source. The heat source for the boiling-distilled-water treatment shall be a Meeker burner, preferably $1\frac{1}{8}$ in. inside diameter, placed directly under the cylinder, midway between the ends. The distance from the top of the burner to the bottom of the glass cylinder shall be $2\frac{1}{8}$ in. The flame shall be protected from drafts.

23f. Rate of boiling. Boiling shall take place at the middle of the cylinder only. The rate of boiling shall be as slow as is consistent with maintaining a positive, continuous boil.

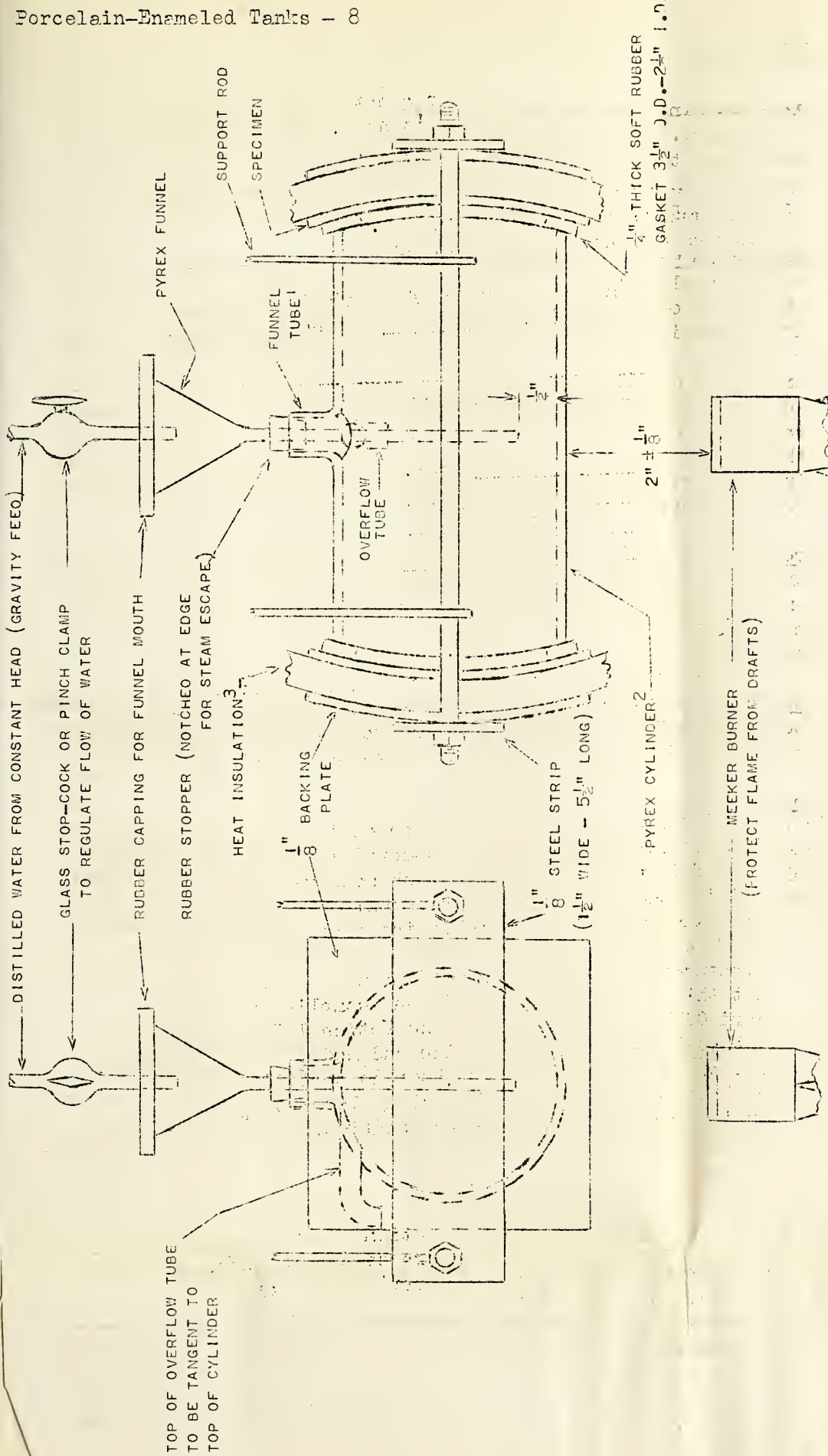
23g. Final glass measurements. At the end of the 7-day treatment the water in contact with the specimens shall be allowed to cool, the specimens removed and, before drying, washed with a rag wetted with a 1-percent solution of trisodium phosphate. They shall then be rinsed, first in tap water and then in distilled water or ethyl alcohol, and allowed to dry in the air. Gloss measurements shall then be made, using the same procedure outlined in paragraph 23c. For these final measurements, specimens shall be placed over the gloss opening of the reflectometer in the exact positions that were used for making the initial gloss measurements.

23h. Percentage of gloss retained. The percentage of initial specular gloss retained by each specimen after the treatment outlined in paragraph 23d shall be computed for the two positions used for gloss measurements. The average percentage for the two positions shall constitute the value for one specimen, and the average for the two specimens shall be taken as the percentage of specular gloss retained for the enamel.

MARKING AND LABELING

24. Markings. The following information shall be marked permanently and plainly in a conspicuous place on the tank.

1/ The apparent specular gloss of a curved tank section will be somewhat lower, depending on the curvature, than that of the same enamel applied on a flat plate, since both are measured against a flat standard. However, the value after test will be proportionately lower, and thus the percentage of gloss retained can be correctly determined.



1. PYREX FUNNEL TUBE, 20 in. O.D., 19 in. LONG FROM TOP OF CYLINDER TO TOP OF TUBE.
2. PYREX CYLINDER, 80mm O.D. LENGTH ON CENTER LINE, 152mm, ENDS CURVED TO SUIT RADIUS OF TANK CYLINDER. PROPER CURVATURE AT ENDS OF GLASS CYLINDER MAY BE OBTAINED BY LAPPING ON THE METAL SURFACE OF 12" OR 14" TANK, USING NO. 150 OR NO. 180 SILICON CARBIDE.
3. HEAT INSULATION TO CONSIST OF A PACK OF 8 SHEETS OF DRY 1/16" ASBESTOS PAPER (JOHNS-MANVILLE, 35"), CUT TO FIT SPECIMEN.

FIGURE 1. APPARATUS FOR BOILING-DISTILLED-WATER TREATMENT

- (a) The manufacturer's name and/or a nationally registered trade mark, or distributor's name.
- (b) The rated capacity in U. S. gallons.
- (c) The maximum rated hydrostatic test pressure for which the tank is designed.
- (d) The maximum rated working pressure.
- (e) Month and year of manufacture, or serial number of the tank.
- (f) Form of label (month and year of manufacture may be substituted for No. _____ in the last line.)

Name or trade mark

_____ gal.

_____ H.P.

_____ W.P.

No. _____

*25. Certification.

25a. The porcelain-enameled tank manufacturers, in order to safeguard the quality of their products, have designated an impartial testing laboratory to obtain and test periodically representative tanks to determine whether they comply with the requirements of this standard and to make periodical reexaminations and tests.

25b. In order that the purchaser may be assured that he is obtaining a porcelain-enameled tank conforming with this commercial standard, the above group of manufacturers affix to each finished tank complying therewith or other appliance containing such a tank, a decalcomania or other permanently attached label or plate incorporating the following statement:

The manufacturer or distributor whose name appears hereon guarantees that this porcelain enameled tank complies with Commercial Standard CS115-44 as issued by the National Bureau of Standards and that it is of the same size and model and of identical construction to tanks which have been so certified by A.G.A. Testing Laboratories, official testing laboratory for the Porcelain Enameled Tank Manufacturers Association.

*Note.- Unexpected developments prevented completion of arrangements for the labeling plan outlined in paragraphs 25a and 25b; however, individual manufacturers or distributors may be requested to certify that porcelain enameled tanks comply with this Commercial Standard.

ACCEPTANCE OF COMMERCIAL STANDARD

If acceptance has not previously been filed, this sheet properly filled in, signed, and returned will provide for the recording of your organization as an acceptor of this commercial standard.

Date

Division of Trade Standards,
National Bureau of Standards,
Washington 25, D. C.

Gentlemen:

Having considered the statements on the reverse side of this sheet, we accept the Commercial Standard CS115-44 as our standard of practice in the

Production <u>1/</u>	Distribution <u>1/</u>	Use <u>1/</u>	Testing <u>1/</u>
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of Porcelain-Enameled Tanks for Domestic Use.

We will assist in securing its general recognition and use, and will cooperate with the standing committee to effect revisions of the standard when necessary.

Please send me a printed copy of the standard when available.

Signature of
Individual Officer _____
(in ink)

(Kindly typewrite or print the following lines)

Name and title
of above officer

Organization
(Fill in exactly as it should be listed in pamphlet)

Street address

City and State

1/ Please designate which group you represent by drawing lines through the other three. Please file separate acceptances for all subsidiary companies and affiliates which should be listed separately as acceptors. In the case of related interests, trade papers, etc., desiring to record their general approval, the words "In Principle" should be added after the signature.

TO THE ACCEPTOR

The following statements answer the usual questions arising in connection with the acceptance and its significance:

1. Enforcement.—Commercial standards are commodity specifications voluntarily established by mutual consent of those concerned. They present a common basis of understanding between the producer, distributor, and consumer and should not be confused with any plan of governmental regulation or control. The United States Department of Commerce has no regulatory power in the enforcement of their provisions, but since they represent the will of the interested groups as a whole, their provisions through usage soon become established as trade customs, and are made effective through incorporation into sales contracts by means of labels, invoices and the like.

2. The acceptor's responsibility.—The purpose of commercial standards is to establish for specific commodities, nationally recognized grades or consumer criteria and the benefits therefrom will be measurable in direct proportion to their general recognition and actual use. Instances will occur when it may be necessary to deviate from the standard and the signing of an acceptance does not preclude such departures; however, such signature indicates an intention to follow the commercial standard where practicable, in the production, distribution, or consumption of the article in question.

3. The Department's responsibility.—The major function performed by the Department of Commerce in the voluntary establishment of commercial standards on a Nation-wide basis is fourfold: first, to act as an unbiased coordinator to bring all interested parties together for the mutually satisfactory adjustment of trade standards; second, to supply such assistance and advice as past experience with similar programs may suggest; third, to canvass and record the extent of acceptance and adherence to the standard on the part of producers, distributors, and users; and fourth, after acceptance, to publish and promulgate the standard for the information and guidance of buyers and sellers of the commodity.

4. Announcement and promulgation.—When the standard has been endorsed by a satisfactory majority of production or consumption in the absence of active, valid opposition, the success of the project is announced. If, however, in the opinion of the standing committee or the Department of Commerce, the support of any standard is inadequate, the right is reserved to withhold promulgation and publication.